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NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

By Dr. WILLIAM J. ROBBINS

UNIVERSITY OF MISSOURI

NATIONAL research fellowships in the biological sciences were established in 1923, supported by grants from the Rockefeller Foundation and administered, under the auspices of the National Research Council, by a National Fellowship Board in the Biological Sciences. The National Research Fellowships in the physical and biological sciences will be administered in the future by a single National Research Fellowship Board in the Natural Sciences. In view of the merging of the two fellowship boards, one in the biological sciences and one in the physical sciences, it seems appropriate at this time to make a report on certain aspects of the activities of the Fellowship Board in the Biological Sciences.

In the fourteen years from 1923 to 1937 the board administered the expenditure of $1,280,580.74, distributed as follows:

For fellowships:	
Domestic stipends	$ 982,325.25
Foreign stipends	183,165.92
Domestic travel	10,408.59
Foreign travel	31,247.92
Tuition and laboratory fees	4,800.89
Total	**1,211,948.57**
For administration:	
Travel, board members	15,035.01
Travel, applicants	4,072.81
Office expense	49,524.35
Total	**68,632.17**
Grand total	**1,280,580.74**

As may be noted from these figures, the amount devoted to tuition and laboratory fees was small. This is because the fellowships were regarded as a cooperative program between the universities and the National Research Council, in which the universities supplied the place of work and equipment and the council the stipends of the fellows. It is not possible to estimate accurately the value of the services and material supplied in this way by the institutions at which the fel-

lows spent their fellowships, but conservatively stated the contribution made by institutions to the fellowship plan probably amounts to $200,000 or more. The assistance was given freely and is an item of no small importance in the success of the fellowship program. Furthermore, the cost of administration has been minor, amounting to 5.4 per cent. of the total funds expended. This is in part because the fellowships were administered by a group of scientists actively engaged in teaching and research, who regarded the funds they administered as a public trust and gave their time to the program freely and without compensation.

The fields covered by the board throughout its history were anthropology, botany, zoology and psychology. Agriculture and forestry in their more fundamental aspects were added in 1926. A policy of rotation in the membership of the board was followed, with the result that although the membership at no time exceeded twelve, many more individuals than this number served on the board for longer or shorter periods. The following is a list of names, fields and terms of service of the members of the board for its entire history:

Agriculture

Cole, L. J.	July 1, 1926–June 30, 1936
Emerson, R. A.	July 1, 1934–March 1, 1937
Kraus, E. J.	July 1, 1929–June 30, 1934
Riley, William A.	July 1, 1936–March 1, 1937

Anthropology

Cole, Fay-Cooper	July 1, 1929–June 30, 1931
Jenks, A. E.	*1923–June 30, 1924
Kidder, A. V.	July 1, 1926–June 30, 1927
Lowie, R. H.	July 1, 1931–June 30, 1934
Sapir, Edward	July 1, 1932–June 30, 1936
Shapiro, H. L.	July 1, 1934–March 1, 1937
Tozzer, A. M.	July 1, 1929–June 30, 1932
Wissler, Clark	*1923–June 30, 1929

Botany

Allen, O. E.	July 1, 1929–June 30, 1931
Bartlett, H. H.	*1923–June 30, 1931
Chandler, W. H.	July 1, 1936–March 1, 1937
Crocker, William	July 1, 1927–June 30, 1929
Duggar, B. M.	July 1, 1925–June 30, 1927
Gardner, M. W.	July 1, 1932–June 30, 1936
Harper, R. A.	*1923–June 30, 1924
Johnson, D. S.	July 1, 1931–June 30, 1932
Kunkel, L. O.	July 1, 1929–June 30, 1932
Lewis, I. F.	July 1, 1933–June 30, 1936
Nichols, G. E.	July 1, 1934–March 1, 1937
Osterhout, W. J. V.	*1923–June 30, 1930
Robbins, W. J.	July 1, 1930–March 1, 1937
Sinnott, E. W.	July 1, 1931–June 30, 1934

Forestry

Bailey, I. W.	July 1, 1929–June 30, 1933
Hartley, Carl	July 1, 1933–March 1, 1937

Psychology

Bentley, Madison	July 1, 1930–June 30, 1934
Carr, Harvey	July 1, 1934–March 1, 1937
Dodge, Raymond	*1923 only
Dunlap, Knight	July 1, 1927–June 30, 1930
Hull, Clark L.	†November 5, 1935
Hunter, Walter S.	July 1, 1936–March 1, 1937
Johnson, H. M.	July 1, 1930–June 30, 1933
Peterson, Joseph	‡July 1, 1933–September 21, 1935
Poffenberger, A. T.	July 1, 1932–June 30, 1934
Seashore, C. E.	*1923–June 30, 1930
Stratton, G. M.	July 1, 1925–June 30, 1926
Thorndike, E. L.	*1923–June 30, 1931
Woodworth, R. S.	July 1, 1924–June 30, 1925

Zoology

Banta, A. M.	July 1, 1933–March 1, 1937
Coker, R. E.	July 1, 1936–March 1, 1937
Curtis, W. C.	July 1, 1930–June 30, 1931
Grave, Caswell	July 1, 1934–March 1, 1937
Harrison, Ross G.	July 1, 1929–June 30, 1932
Jacobs, M. H.	July 1, 1931–June 30, 1934
Jennings, H. S.	July 1, 1930–June 30, 1933
Lillie, F. R.	*1923–June 30, 1932
McClung, C. E.	*1923–June 30, 1929
Metcalf, M. M.	July 1, 1924–June 30, 1925
Morgan, T. H.	*1923–June 30, 1930
Payne, F.	July 1, 1932–June 30, 1933
Tennent, D. H.	July 1, 1932–March 1, 1937
Woodruff, L. L.	July 1, 1928–June 30, 1931

SECRETARIES OF THE BOARD AND THEIR TERMS OF SERVICE

Edith Elliott Conger	From organization of board in 1923 to June 30, 1931
Susie G. Barnum	July 1, 1931–March 1, 1937

CHAIRMEN OF THE BOARD AND THEIR TERMS OF SERVICE

Lillie, F. R.	1923–June 30, 1932
Robbins, W. J.	1932–March 1, 1937

* Member of board when organized in 1923.
† Appointed to fill out the term of Dr. Joseph Peterson.
‡ Deceased on September 21, 1935.

The fellowships were post-doctoral in character and open to men or women of United States and Canadian citizenship who had completed the degree of doctor of philosophy or its equivalent. The purpose was to promote research in the fundamental branches of the biological sciences by aiding in the development of promising young investigators. Through the medium of the fellowships it was hoped that research might be continued into the post-doctoral years and that the fellow, after an association with men and institutions well fitted to advance his development, would remain productive in his chosen field. Since the board was more concerned with the effect of the fellowship upon later research than the research completed during the fellowship, the appointees were as a rule individuals who had recently completed the requirements for the doctor's degree and not over thirty-five years of age.

During the past fourteen years the board considered a total of 1,750 applications, of which 1,414 were for new appointments and 336 for reappointment. Of the applicants for new appointments 398 were appointed.

DISTRIBUTION OF APPLICANTS AND APPOINTEES BY FIELDS

Of the total number (1,414) of new applicants, 4.5 per cent. were in anthropology, 23 per cent. in botany, 21 per cent. in psychology, 39 per cent. in zoology and 12.5 per cent. in agriculture and forestry. Of the applicants in each field the following proportions were appointed: anthropology, 50 per cent.; botany, 30 per

cent.; psychology, 30 per cent.; zoology, 24.5 per cent., agriculture and forestry, 25.5 per cent.

PLACE OF STUDY

The place of study was selected by the fellow with the advice and approval of the board. While, as might be anticipated, there was a concentration of fellows at the larger and stronger institutions, nevertheless the distribution of places of study was surprisingly wide. Fellows studied at fifty-six institutions in the United States and Canada and at forty-nine foreign institutions.

SOURCE OF NATIONAL RESEARCH FELLOWS

Since the applicants and the fellows are a selected group of highly trained individuals, it is of some interest to determine their origins. Where did the applicants and fellows of the National Research Fellowship Board in the Biological Sciences secure their undergraduate and their graduate training?

UNDERGRADUATE TRAINING

The undergraduate training of applicants and fellows was secured at a surprisingly large number of institutions. Applications were received from students with baccalaureate degrees from 280 colleges and universities, of which thirteen were Canadian universities and ten those of other foreign countries. Fellows were appointed with undergraduate degrees from 165 colleges and universities, of which ten were Canadian and four those of other foreign countries. It is evident that the undergraduate training of those who seek careers in research in the biological sciences is not centralized in a few institutions. Many of the institutions at which applicants and fellows secured their undergraduate training were small. In fact, some institutions with registrations of from 400 to 800 gave undergraduate training to as many applicants and fellows as did some institutions with registrations of from 10,000 to 28,000. That there is no necessary relation between the size of an institution and the proportion of the students who went on into graduate work and were appointed fellows is evident from the following:

According to the 1935 Educational Directory of the United States Office of Education there were 461 institutions in the United States and Canada with annual enrolments of less than 1,000. The average enrolment of the institutions was 406. A total of 83 fellows was appointed with baccalaureate degrees from sixty-four of the 461 institutions. This is at the rate of forty-four fellows per 100,000 enrolment of all institutions in this class. Comparable figures are given in Table I for institutions having enrolments of between 1,000 and 2,999, institutions with enrolments of between 3,000 and 4,999 and for institutions of 5,000 and over.

It seems clear from the data in Table I that a student who wishes to enter the field of research in the biological sciences is not necessarily handicapped by taking his undergraduate work at a small institution. The number of fellows per 100,000 registration in institutions of different sizes shows no regular trend. It must be admitted, however, that registration in professional schools and in the graduate schools in the larger institutions and the probable omission of some of the smaller schools from the list consulted, weight the statistics in favor of the small institutions. No explanation is at hand for what appears to be a low figure for institutions with enrolments of from 3,000 to 4,999. It is rather surprising that in the period of fourteen years some institutions (eight out of thirty-seven) with annual enrolments of 5,000 and over are not represented by a single fellow who completed his undergraduate work at those institutions.

The institutions from which three or more fellows received baccalaureate degrees are given in Table I, grouped according to enrolments as given in the 1935 Educational Directory of the U. S. Office of Education.

TABLE I

Institution	Enrolment	Fellows with bachelor's degree
Institutions with Enrolments of Less than 1,000:		
Acadia University	466	3
Goucher College	630	4
Hamilton College	480	3
Hope College	500	3
Institutions with enrolments of from 1,000 to 2,999:		
University of British Columbia	1,752	3
Dartmouth College	2,479	6
University of Florida	2,848	3
Johns Hopkins University	1,816	8
University of Manitoba	2,520	3
Massachusetts State College	1,238	3
McGill University	2,675	4
Oberlin College	1,621	5
Princeton University	2,622	3
Rutgers University	2,448	4
Tufts College	2,042	3
Utah State College of Agriculture	2,380	4
Institutions with enrolments of from 3,000 to 4,999:		
Iowa State College	4,695	3
Kansas State Agricultural College	3,436	4
Pennsylvania State College	4,621	5
Stanford University	3,848	6
Institutions with enrolments over 5,000:		
University of California	21,125	23
University of Chicago	11,054	9
Columbia University	30,211	14
Cornell University	5,717	13
Harvard University	7,729	13
University of Illinois	13,067	5
Iowa State University	8,064	5
University of Michigan	9,570	12
University of Minnesota	13,393	9
University of Missouri	5,483	7
University of Nebraska	7,486	5
College of the City of New York	22,182	3
New York University	28,269	3
Ohio State University	13,505	4
University of Pennsylvania	6,233	4
University of Texas	8,159	4
University of Toronto	7,711	3
University of Washington	12,148	3
University of Wisconsin	8,657	14
Yale University	5,362	6

Four only out of 461 institutions with annual registrations of less than 1,000 are represented by three or more fellows. For institutions of enrolments between 1,000 and 2,999 there were twelve out of 112; for institutions of between 3,000 and 4,999 students there were four out of twenty-nine; and for institutions with enrolments of 5,000 there were twenty out of thirty-seven.

The geographical distribution of applicants and fellows in the United States, tabulated according to the place of undergraduate training, shows all sections of the United States represented (Table Ia), but not

TABLE Ia

NUMBER OF APPLICANTS AND APPOINTEES OF THE NATIONAL RESEARCH FELLOWSHIP BOARD IN THE BIOLOGICAL SCIENCES ARRANGED BY GEOGRAPHICAL SECTIONS ACCORDING TO PLACE OF BACCALAUREATE DEGREES*

Section of U. S.†	Number of applicants	Applicants per 10,000 students in collegiate departments	Fellows	Fellows per 10,000 students in collegiate departments
New England	141	41	45	13.2
Middle Atlantic ..	330	25	95	7.3
East Central	294	26	85	7.5
West Central	214	34	62	9.7
East South	69	12	15	2.7
West South	48	10	12	2.5
Northwest	71	38	11	6.0
Southwest	140	21	40	6.0

* Enrolment figures as given in World Almanac of 1936.
† New England includes Massachusetts, Maine, Vermont, New Hampshire, Rhode Island, Connecticut; Middle Atlantic includes New York, Pennsylvania, New Jersey, Delaware, Maryland, West Virginia, Virginia and District of Columbia; East Central includes Wisconsin, Illinois, Indiana, Ohio, Michigan, Kentucky; West Central includes North Dakota, South Dakota, Minnesota, Nebraska, Iowa, Missouri and Kansas; East South includes North Carolina, South Carolina, Tennessee, Georgia, Mississippi, Alabama and Florida; West South includes Arkansas, Oklahoma, Texas and Louisiana; Northwest includes Washington, Oregon, Idaho, Montana and Wyoming; Southwest includes California, Nevada, Utah, New Mexico, Colorado and Arizona.

equally. The applicants who received undergraduate training in the south were fewer in number than those who received similar training in the New England states or in the Southwest, less than one half of those from the East Central or West Central and about one third of those from the Middle Atlantic States. The number relative to collegiate enrolment (excluding the graduate and professional schools) is still more significant. Relative to collegiate enrolment more applicants came from the New England, West Central and Northwest sections than from others, and by far the fewest came from the South.

The distribution of fellows (Table II) arranged geographically, according to undergraduate training, is much similar to that of the applicants. However, a comparison of the ratio of fellows to applicants for a given section shows that about 30 per cent. of the applicants with undergraduate training from institutions in the New England, Middle Atlantic, East Central and West Central sections were appointed fellows; for the South and Southwest from 22 to 25 per cent. of the candidates were appointed and from the Northwest but 14 per cent. The reasons for the unequal geographic distribution of applicants classified on the basis of undergraduate training are various. One of them is, without doubt, the accessibility of good graduate schools, but other factors also play a part. The apparent discrimination between the different sections in the proportion of applicants appointed fellows also is the result of several influences which space precludes discussing here.

TABLE II

NUMBER OF FELLOWS ON BASIS OF BACCALAUREATE DEGREE FROM INSTITUTIONS OF DIFFERENT SIZES*

Size of institution based on enrolment	Total institutions	Average enrolment	No. of institutions at which baccalaureate degrees were taken	Number of fellows with baccalaureate degrees from institutions indicated	Fellows per 100,000 students in the institutions indicated
Less than 1,000 ..	461	406	64	83	44
1,000–2,999	112	1,750	52	104	53
3,000–4,999	29	3,875	14	32	28
5,000 and over ...	37	10,111	29	174	46

* Enrolment figures taken from the 1935 Educational Directory of the United States Office of Education.

GRADUATE TRAINING

Individuals with doctorates from sixty-four institutions in the United States and Canada and from twelve foreign institutions were included amongst the applicants. Fellows with doctorates from forty-one institutions in the United States and Canada and from six foreign institutions were appointed.

Graduate study is of necessity more highly centralized than undergraduate study. This is clear from a casual glance at Table III, in which the applicants and fellows are arranged by regions based on the

TABLE III

NUMBER OF APPLICANTS AND APPOINTEES NATIONAL RESEARCH FELLOWSHIP BOARD IN THE BIOLOGICAL SCIENCES ARRANGED BY GEOGRAPHICAL SECTIONS ACCORDIND TO PLACE OF GRADUATE STUDY

	Applicants	Fellows
New England	214	85
Middle Atlantic	428	136
East Central	307	79
West Central	192	55
East South	19	4
West South	13	2
Northwest	18	2
Southwest	146	35

source of their doctors' degrees. In fact, the graduate schools of eight states (California, Connecticut, Illinois, Maryland, Massachusetts, New York, Pennsylvania and Wisconsin) furnished 925 applicants (65 per

cent. of the total) and 296 fellows (75 per cent. of the total).

A comparison of the figures in Table II and Table III shows the movement of undergraduates from the West Central and South to New England, Middle Atlantic and East Central sections for graduate work. Only 141 of the applicants took their undergraduate work in the New England States, but 214 secured a doctor's degree there. One hundred and seventeen of the applicants took their undergraduate work in the south, but only thirty-two secured their doctor's degrees there.

Again there is a difference between different sections in the percentage of applicants appointed as fellows. Of the applicants who completed work for the doctorate in the New England States, 39 per cent. were appointed fellows; for the Middle Atlantic States the percentage is 32; for the West Central, 28; the East Central, 25; the Southwest, 24; the East South, 21; the West South, 16; and the Northwest, 11.

In Table IV institutions are arranged according to the number of fellows having a doctor's degree from the institution. Institutions represented by less than three doctorates in the list of fellows are omitted. The ranking of these institutions in graduate work as given by Eells and based on the report of the Hughes Committee of the American Council on Education is given also.

TABLE IV

FELLOWS ARRANGED ACCORDING TO THE SOURCE OF DOCTORATE

Institutions	Fellows	Ranking by Eells*
Harvard University	49	University of California
Cornell University	32	Harvard University
Columbia University	30	Columbia University
University of Wisconsin	30	University of Wisconsin
Johns Hopkins University	29	University of Chicago
Yale University	26	Cornell University
University of California	25	Yale University
University of Chicago	20	University of Michigan
University of Minnesota	16	Johns Hopkins University
University of Michigan	14	University of Minnesota
University of Pennsylvania	14	University of Illinois
Iowa State University	13	Princeton University
University of Missouri	8	Stanford University
Princeton University	7	Ohio State University
Stanford University	7	University of Pennsylvania
Washington University	7	Massachusetts Institute of Technology
Iowa State College	6	Iowa State University
Clark University	5	California Institute of Technology
Ohio State University	5	University of Missouri
Brown University	4	Iowa State College
University of Kansas	4	Northwestern University
University of Illinois	4	New York University
University of Toronto	4	University of Texas
University of Pittsburgh	3	Bryn Mawr
University of Virginia	3	University of North Carolina; Washington University

* Walter C. Eells, *School and Society*, 39: 708–712, 1934.

With few exceptions those institutions ranked by Eells as having strong graduate schools are those at which the greatest number of fellows secured their graduate training. The ten institutions at which the greatest number of fellows secured their graduate training are the first ten on the list of Eells. The next ten in Eells's list include only three which are not in the second ten in the ranking according to number of fellows. Two of these are primarily concerned with the physical sciences.

EFFECT OF THE FELLOWSHIP PROGRAM

To evaluate a program of this character in terms of its primary purpose, its effect upon biological research, is difficult, and it is not the purpose of this factual report to do so. It appears, however, that the majority of the former fellows are located in institutions in which it should be possible for them to use their training in further research. Former fellows are now associated in a professional capacity with 125 institutions at home and abroad and tend to be concentrated at the larger and stronger research institutions. The institutions with four or more former national research fellows in the biological sciences now on their staffs are as follows:

Harvard University	19
University of California	15
U. S. Dept. of Agriculture	14
Columbia University	12
University of Wisconsin	11
Yale University	11
Cornell University	8
University of Michigan	7
University of Pennsylvania	7
Rockefeller Institute	7
University of Chicago	6
University of North Carolina	6
California Institute of Technology	5
State University of Iowa	5
Iowa State College	5
Johns Hopkins University	5
University of Minnesota	5
University of Missouri	5
Brown University	4
Duke University	4
New York University	4
Washington University	4

Two former fellows are in commercial positions, three are unemployed, six doing independent research or writing, and no information is available on seven.

This brief report summarizes certain aspects of the national research fellowships in the biological sciences characterized by Lillie[1] as "a rather magnificent experiment in post-doctoral education." The effects of a fellowship program of this type, which has had as its primary purpose the training of a selected group

[1] Frank R. Lillie, "Post-doctoral Training for Productive Scholarship." Thirty-seventh Annual Conference of the Association of American Universities, 1935, pp. 147–153.

of men and women for research, will extend over many years. Its success can best be judged at a later time, since few of the national research fellows in the biological sciences have completed their fellowships for more than ten years and the majority less than five years.

SCIENTIFIC EVENTS

FILM SHOWINGS AT THE ANNUAL SCIENCE EXHIBITION

IN line with extended interest and usefulness of films to scientists, new features will be inaugurated at the coming exhibition in Murat Theater, Indianapolis, December 27 to 30. The members of the American Association for the Advancement of Science are requested to bring either long or short films which have been made either in connection with research or hobby. Unusual films or those with sound track are most desirable. Mr. Loyd A. Jones has promised the use of his film, "Motion Photomicrographs of Growing Crystals." This was first shown at the eightieth annual exhibition of the Royal Photographic Society of Great Britain. Dr. A. C. Ivy will permit the showing of his film portraying the motions in the gall bladder. This new feature is through the courtesy of the Bell and Howell Company jointly with the E. L. Bruce Company. The latter will also show an interesting science film called "Hidden Enemies."

The Eastman Kodak Company will give an interesting demonstration of the Eastman Special 16mm sound Kodascope along with other new Eastman developments.

The Erpi Picture Consultants, Inc., will show films produced in collaboration with the University of Chicago. The subjects to be presented will include: Mechanisms of breathing; the heart and circulation, body defenses against disease; the nervous system; velocity of chemical reactions; the earth in motion; the solar family; the moon; exploring the universe; digestion; catalysis, and light and colloids.

To promote interest in this new feature advance information to the director of exhibits would be helpful, especially concerning other films that are available.

F. C. BROWN,
Director of Exhibits

THE GRADUATE FORTNIGHT OF THE NEW YORK ACADEMY OF MEDICINE

DR. JAMES ALEXANDER MILLER, president of the New York Academy of Medicine, welcomed the participants of the tenth annual Graduate Fortnight of the New York Academy of Medicine, which opened on November 1. He briefly reviewed the opportunities afforded by the lectures, by the clinical conferences and by the exhibit housed in the Academy of Medicine, for an inclusive and intensive review of what is known concerning the diseases and the medical and surgical treatment of the genito-urinary tract. In pointing out the importance of graduate education he said:

> If the medical profession is to fulfil its obligations to the public, no physician can afford to discontinue being a student after he is graduated in medicine. Otherwise he will gradually deteriorate professionally. One of the aims of the Academy of Medicine is to place the extraordinarily fine opportunities for graduate instruction which New York City affords at the disposal of the physicians of the city and of the neighboring communities. It is with these objectives in mind that the Graduate Fortnight was organized and during the ten years of its existence it has become increasingly valuable in the field of graduate medicine.

The addresses of the evening were given by Dr. Alfred N. Richards, professor of pharmacology at the University of Pennsylvania, and by Dr. Donald D. Van Slyke, of the Rockefeller Institute for Medical Research. Dr. Richards delivered the Wesley M. Carpenter lecture. His topic was "The Physiology of the Kidney." Dr. Van Slyke spoke on "Tests for Kidney Function." Approximately 2,500 physicians from New York City and surrounding communities participated in the sessions. The theme of the Graduate Fortnight was "Medical and Surgical Disorders of the Urinary Tract." The subject included Bright's disease, arterial hypertension, infections, tumors, calculi and obstructions of the urinary tract.

The Graduate Fortnight holds a series of ten evening lectures held in the academy, and thirty-six morning and afternoon clinical conferences and demonstrations in twenty-four city hospitals. An exhibition on the Medical and Surgical Disorders of the Urinary Tract was on view at the academy.

THE NEW YORK MEETING OF THE AMERICAN PUBLIC HEALTH ASSOCIATION

THE sixty-sixth annual meeting of the American Public Health Association, which was held from October 5 to 8 in New York City, registered a larger number of delegates than at any meeting in its history. The registration was 3,549. The next highest registration was at Chicago in 1928, when slightly more than 2,500 were registered. At the New York City meeting, every state in the Union was represented, Canada, Cuba, Mexico, Puerto Rico, Alaska, Hawaii, Philippine Islands, England, Germany, France, Belgium,

Japan, Switzerland, India, Finland, Holland, Turkey and Ireland. All sessions were exceptionally well attended. Two meetings to which the public was invited, held in the Manhattan Opera House, filled the auditorium.

In recognition of the excellence of both technical and scientific exhibits the Governing Council passed a resolution of commendation. The awards for scientific exhibit excellence were announced as follows:

1. The Rockefeller Institute for Medical Research and The International Health Division of the Rockefeller Foundation.
2. Otto Neurath, president, International Foundation for Visual Education.
3. New York World's Fair, 1939, Inc.
4. Metropolitan Health Department of British Columbia, Canada.
5. New York City Cancer Committee.
6. American Medical Association.

Among the resolutions adopted were:

A resolution reiterating the attitude of the association toward the removal of public health administration from political interference and control.

A resolution in favor of Congressional appropriations for a minimum of two years for a nation-wide statistical survey of the accident problem.

A resolution supporting the development of more adequate diagnostic services for the control of syphilis.

A resolution supporting the Vinson Bill as the best procedure and organization for lessening the danger to public health from stream pollution.

A resolution pledging active support to measures which seek to secure better maternal and neo-natal care.

A resolution authorizing a special committee to study the public health aspects of medical care, especially of chronic diseases.

Dr. Arthur T. McCormack was inducted into the office of president; Abel Wolman, professor of sanitary engineering at the Johns Hopkins University, was named president-elect. Dr. Thomas Parran and Dr. John P. Koehler were returned to the executive board and the following ten members were elected to the Governing Council: Drs. W. F. Draper, A. Grant Fleming, Ira V. Hiscock, E. V. McCollum, J. T. Phair, John L. Rice, George C. Ruhland, William P. Shepard, W. G. Smillie and Huntington Williams.

The annual meeting in 1938 will be held at Kansas City.

NOMINATIONS FOR PRESIDENT-ELECT OF THE AMERICAN CHEMICAL SOCIETY

LOCAL sections of the American Chemical Society, in accordance with the constitution and by-laws governing elections, have proposed for nomination members for president-elect and councilors at large. The four names receiving the largest vote will then be put upon the final ballot which goes to members of the council. The nominations are given in *Industrial and Engineering Chemistry* as follows: For president-elect:

William Lloyd Evans, professor and chairman of the department of chemistry at the Ohio State University.

Per K. Frolich, director of the chemical laboratories of the Standard Oil Development Company.

Harry N. Holmes, professor and head of the department of chemistry at Oberlin College.

Charles A. Kraus, professor of chemistry and director of the Newport Rogers Laboratory at Brown University.

Samuel C. Lind, dean of the Institute of Technology of the University of Minnesota.

Carl S. Miner, consulting chemist, Miner Laboratories.

Hobart H. Willard, professor of chemistry at the University of Michigan.

The following have been nominated to serve as councilors-at-large:

William Mansfield Clark, professor of physiological chemistry at the Johns Hopkins University.

A. C. Fieldner, chief of the Technical Branch and chief engineer of the Coal Division of the U. S. Bureau of Mines.

Ivan Gubelmann, chemical director of the Organic Chemistry Division of E. I. du Pont de Nemours and Company, Inc.

B Smith Hopkins, professor of inorganic chemistry, University of Illinois.

G. E. F. Lundell, chief of the Chemistry Division, National Bureau of Standards.

John H. Nair, assistant director of the Research Laboratories of the Borden Company.

A. S. Richardson, director of chemical research, Procter and Gamble Company.

H. A. Shonle, research organic chemist, Eli Lilly and Company.

GRANTS AWARDED BY THE AMERICAN PHILOSOPHICAL SOCIETY

GRANTS for research have been awarded as follows by the committee on research of the American Philosophical Society:

D. H. Wenrich, University of Pennsylvania, for the continuation of the study of nuclear and other variations in the parasitic amoebae of man ..... $ 500

Horace G. Richards, New Jersey State Museum, for the collection and study of the land mollusks of the Island of Roatan, Honduras, with special attention to the bearing of this fauna on problems of paleogeography 200

Edward Girden, Brooklyn College, for the study of the relationship between bone-conduction and air-borne waves in the auditory acuity of dogs, and the effect of cortical extirpation upon these functions 350

T. M. N. Lewis, University of Tennessee, for archeological field research in Tennessee 1,000

Edward Horne Craigie, University of Toronto, for the study of vascularity in the brains of amphibians and reptiles ..... $ 225

George Kreezer, The Training School at Vineland, N. J., for the determination of the properties of the human electro-encephalogram at different levels of intelligence and for different types of mental deficiency 500

Marie Channing Linthicum, Salem College, for the investigation of the history of the costuming of allegorical, symbolic and type characters on the English stage 400

Elsa Guerdrum Allen, Cornell University, for the study of the history of American ornithology before Audubon 400

V. M. Slipher, Lowell Observatory, for the completing of the systematic search of the wide ecliptic belt of the sky for more distant planetary members of the solar system 2,000

Arthur E. Ruark, University of North Carolina, for cloud chamber studies of positron-electron pairs 1,250

Edward Sapir, Yale University, to obtain supplementary text material in Navaho 400

Gabriel Bonno, University of California, for the study of the intellectual relations between Great Britain and France from 1715 to 1735 750

James A. Geary, Catholic University of America, for a field study of the phonology and inflexions of Algonkin and related Algonquian dialects in Quebec and Ontario 400

Edward B. Logan, University of Pennsylvania, for the study of the direct primary system in Pennsylvania 1,000

Norman John Berrill, McGill University, for the study of the histology of growth in post-embryonic development, with special reference to the origin of new types of tissue, tissue repair, and regeneration 1,100

Moravian Seminary and College for Women, Bethlehem, Pa., for research in Moravian music manuscripts located at Bethlehem, Pa., leading to a complete and authoritative catalogue of the material and a historical monograph summarizing the findings of the study 2,000

Carl C. Lindegren, University of Southern California, for the study of the mechanism of crossing-over in the regions distal to the spindle-fiber-attachment in the chromosomes of *Neurospora crassa* 500

Hellmut deTerra, Academy of Natural Sciences, for an archeological survey in Upper Burma 2,500

Henry L. Savage, Princeton University, for the investigation of the background of the Middle English poem "Sir Gawain and the Green Knight" 400

Winona Welch, DePauw University, for the completion of the monograph study of the Fontinalaceae of the world 800

Davenport Hooker, University of Pittsburgh, for functional and morphological studies of human prenatal development 2,500

Edward W. Berry, Johns Hopkins University, for the completion of papers on Upper Cretaceous and Paleocene floras from Patagonia and from two horizons on the Island of Trinidad, B. W. I. ..... $ 100

Millar Burrows, Yale University, for preliminary excavations at Tell el-Kheliefeh, a small mound in southern Transjordan, just outside of Aqabah 900

Elmer D. Merrill, Harvard University, for a taxonomic and phytogeographic consideration of the Bornean species of Eugenia 750

Union Library Catalogue of the Philadelphia Metropolitan Area 6,000

Tracy M. Sonneborn, Johns Hopkins University, for the study of sex, sex inheritance and sex determination in ciliate protozoa 720

Rudolf Höber, University of Pennsylvania, for investigations concerning intestinal absorption in mammals, influence of organic substances upon the resting potential of muscles and nerves and upon contractility of muscles, secretion of the isolated liver 2,000

F. J. M. Sichel, University of Vermont, for the study of the excitation properties of the contractile mechanism in skeletal muscle 600

Mary Butler, University Museum of Pennsylvania, for the study of Maya archeological material, chiefly pottery, from the Chama district of the highlands of Guatemala 1,800

Carl Bachman and D. Wright Wilson, University of Pennsylvania, for a cooperative study of sex hormones: (a) Purification, chemical and biological study of pregnancy prolan; (b) Study of the quantitative metabolism of oestrogenic hormones and pregnandiol in normal and pathologic pregnancy 2,400

Fred E. D'Amour, University of Denver, for the determination of the time of ovulation in normal women by analysis of the urine for gonadotropic hormone 1,000

F. K. Richtmyer, Cornell University, for the study of double ionization of inner electron of inner electron shells of atoms 1,800

Eliot R. Clark, University of Pennsylvania, for the study of living cells and tissues in the living mammal with aid of artificially installed transparent windows and chambers 2,500

Ruth B. Howland, New York University, for the continuation of the study of reciprocal transfers of imaginal discs between Drosophila larvae 250

RECENT DEATHS AND MEMORIALS

FRANCIS P. GARVAN, president of the Chemical Foundation, died on November 8 at the age of sixty-two years.

EDWARD R. JONES, professor of agricultural engineering and head of the department at the University of Wisconsin, died on October 22 at the age of fifty-five years.

PROFESSOR HENRY ARTHUR BALLOU, who retired in 1934 as Commissioner of Agriculture of the British

West Indies, died on November 3, at the age of sixty-five years.

Nature reports the death of Sir John Dewrance, past president of the British Institution of Mechanical Engineers, on October 7, aged seventy-nine years; of Sir Ashley Mackintosh, emeritus professor of medicine in the University of Aberdeen, on October 14, aged sixty-nine years, and of Sir John Moore, past president of the Royal Academy of Medicine in Ireland and president of the Royal College of Physicians of Ireland, on October 13, aged ninety-one years.

A CORRESPONDENT writes: On September 12, 1937, the ashes of Dr. David White and his wife, Mary White, were buried in the little cemetery on the edge of the Grand Canyon (near Yavapau Museum), in the Grand Canyon National Park. This was done in accordance with the wishes of Mrs. White, and the mission was carried out by Miss Taisia Stadnichenko, who for a number of years was Dr. White's research associate and close friend of the family. No more appropriate place could have been chosen as a last resting place for this great scientist, who enriched the geological literature with his contributions, for, aside from the splendor of its setting, it was, as Mrs. White appropriately wrote, "close to an area where Dr. White spent several years of work which were perhaps the climax of his almost half a century of labors in his chosen field, and which he counted as richest of his many years of field experience." The ceremonies held at the grave, and attended by a group of friends, included a brief burial service, and appreciative remarks on Dr. White's career and personality, by Heinrich Ries. Dr. White's library has been acquired by the Museum of Northern Arizona at Flagstaff, Ariz., where it is being catalogued and well taken care of.

A FINAL tribute was paid on October 25 to Lord Rutherford by his burial in Westminster Abbey. His ashes were placed in "Science corner," where Newton, Faraday, Darwin and Kelvin are buried. Virtually every institution of learning in Great Britain sent delegations, and groups of scientific men from all parts of the world were represented. The pallbearers included Lord Dawson, president of the Royal College of Physicians; Sir William Bragg, president of the Royal Society, and Sir Edward Poulton, retiring president of the British Association for the Advancement of Science.

SCIENTIFIC NOTES AND NEWS

THE eighty-sixth birthday of Dr. Leonhard Stejneger, head curator at the U. S. National Museum, was celebrated at a dinner given in his honor at the Cosmos Club on October 30. Many letters of congratulation were received from abroad. Wilhelm Morgenstierne, Norwegian Minister to the United States, spoke of Dr. Stejneger's youth; Dr. Alexander Wetmore paid tribute to him as an ornithologist; Professor Albert H. Wright, as a herpetologist; Dr. William M. Mann, as a zoogeographer; Dr. C. W. Stiles, as a nomenclaturist, and Dr. A. K. Fisher, as a man. Dr. Charles G. Abbot, secretary of the Smithsonian Institution, presided, and Dr. Stejneger responded briefly. A presentation by R. P. Tolman, director of the National Collection of Fine Arts, of an original etching of the Smithsonian Building was made at the dinner. In recognition of his scientific work, Dr. Stejneger, who is long past the usual retiring age, has been retained in his present post by presidential order.

DR. F. LAMSON-SCRIBNER, who retired as agrostologist of the U. S. Department of Agriculture in 1922, recently received a visit from D. E. Juan, a native of the Philippine Islands, to express the sentiment of the farmers of the Philippine Islands. As their first director of agriculture, Dr. Lamson-Scribner, now eighty-six years old, introduced into the islands more than thirty-five years ago modern methods of soil tilling and crop harvesting. He was responsible for the establishment of experimental stations throughout the islands. Mr. Juan presented to Dr. Lamson-Scribner a testimonial with the inscription "The Filipino farmers owe you a debt of gratitude."

DR. REINALDO DOS SANTOS, professor of urology at the University of Lisbon, has been awarded the Matas medal of the Tulane University School of Medicine for the advancement of vascular surgery. The medal will be presented on November 26.

IN recognition of his expedition to French Indo-China, and of the zoological collections resulting from it, the Board of Trustees of the Field Museum of Chicago at a meeting held on October 18 added the name of Dr. Wilfred H. Osgood, chief curator of the department of zoology, to the list of the "Museum's Contributors."

DR. HANS DRIESCH, professor of philosophy at the University of Leipzig, celebrated his seventieth birthday on October 28.

DR. ELLIOTT P. JOSLIN, clinical professor of medicine in the Harvard Medical School, was installed as president at the recent St. Louis meeting of the Interstate Postgraduate Medical Association.

AT the New York meeting of the Society of Auto-

motive Engineers, C. W. Spicer, of Toledo, Ohio, was elected president.

THE REV. MICHAEL J. AHERN, S.J., of Weston College, Massachusetts, has been elected chairman of the Northeastern Section of the American Chemical Society, to succeed Dr. Hervey J. Skinner, of Boston.

THE work of reorganization which he was asked to undertake having been completed, Dr. Willard E. Hotchkiss, who since 1933 has been president of the Armour Institute of Technology, Chicago, retired on October 12.

DR. CURRIER MCEWEN, secretary and assistant dean of New York University College of Medicine since 1932, has been appointed dean to succeed the late Dr. John Wyckoff.

PROFESSOR HENRY C. ANDERSON, chairman of the department of mechanical engineering of the University of Michigan, has been made dean of the College of Engineering to succeed Dr. Herbert C. Sadler, who has retired from the deanship and has been appointed to the Alexander Ziwet distinguished professorship of engineering.

DR. HAROLD MESTRE, professor of biophysics at Bard College, Columbia University, has been appointed dean of the college to succeed Professor Donald G. Tewksbury, who has resigned.

PROFESSOR ROSWELL P. ANGIER, chairman of the department of psychology at Yale University, has been appointed associate dean of the Graduate School.

DR. PAUL B. PEARSON, of the University of Wisconsin, has been appointed professor in charge of animal nutrition at the Agricultural and Mechanical Engineering College of Texas.

PROFESSOR DONALD G. PATERSON, of the department of psychology of the University of Minnesota, was named representative in the Division of Anthropology and Psychology of the National Research Council at the recent meeting in Minneapolis of the American Psychological Association, of which he is secretary.

THE REV. ALEXANDRE VACHON, professor of chemistry at Laval University, has been appointed technical counsellor to the Research Fisheries Council of North America. The council is engaged in research work in North Atlantic waters in connection with the fisheries matters pertaining to Canada, in the United States and Newfoundland.

ALBERT JAMES KOOP, who has been keeper of the Department of Metal Work of the Victoria and Albert Museum, London, since 1926, retired on October 14.

AN expedition sponsored by the Museum of Natural Science of Syracuse University and led by Dr. Sidman P. Poole, associate professor of geography, will spend the first two months of 1938 in exploring the Maya country in northern Yucatan in order to make a geographic reconnaissance of the environmental relationships which underlay the New Mayan empire. Dr. Poole was geographer in 1930–31 to the first Andean expedition of the university and served in a similar capacity to the Syracuse expedition through the Gaspé peninsula. The party will include Frederick Foster, manager of the university bookstore, who will serve as chief photographer, and Mr. Joseph Koslowski, graduate of the College of Fine Arts, who will serve as artist.

DR. EMMANUEL DIAS, of the Instituto Oswaldo Cruz, Rio de Janeiro, and Dr. Amilcar Vianna Martins, of the Instituto Ezequiel Dias, Bello Horizonte, Brazil, have visited the United States under the auspices of the Brazilian Government in order to learn the methods used in Rocky Mountain spotted fever prophylaxis. They spent five weeks at Hamilton, Mont., with Dr. R. R. Parker, director of the Rocky Mountain Laboratory, U. S. Public Health Service, where they familiarized themselves with the methods of tick-rearing and vaccine manufacturing. They also visited Dr. M. Ruiz Castañeda and Dr. E. Cervera in Mexico City, and Dr. Hans Zinsser and Dr. S. B. Wolbach in Boston, and spent a few days at the Rockefeller Institute, New York City. The Instituto Ezequiel Dias is planning to build an adequate laboratory where vaccine for spotted fever will be produced with the local tick, *Amblyomma cajennense*, carrier of the disease.

DR. ALFRED BIELSCHOWSKY, director of the Dartmouth Eye Institute, has left for a six weeks' lecture tour abroad. He plans to give two lectures at Copenhagen, before the Danish Ophthalmological Society and the Copenhagen Medical Society, two lectures before the Ophthalmological Society at Lund and two lectures before the Swedish Ophthalmological Society and the Swedish Medical Society at Stockholm.

DR. HARLOW SHAPLEY gave, on November 10, a lecture under the auspices of the Harvard Club at St. Louis on "Exploring Star Galaxies from a South African Kopje (hill)."

DR. DAVID B. DILL, associate professor of industrial physiology at Harvard University, gave in October a Lowell Institute series of eight lectures on "Life in High Temperatures and in Great Heights."

THE forty-second Hanna Lecture of the Academy of Medicine, Cleveland, will be delivered by Dr. Corneille Heymans, professor of pharmacology at the University of Ghent, on "The Control of Vasomotor Tone Blood Supply and Blood Pressure."

DR. WILLIAM E. GYE, director of the Imperial Can-

cer Research Foundation of London, spoke on November 10 before the Yale Medical School on "Tumors Transmissible with Viruses."

Nature reports that the first Radford Mather Lecture of the British Association was given by the late Right Hon. J. Ramsay MacDonald on October 22. His address was entitled "Science and the Community." The Norman Lockyer Lecture, on "Origins of Town Life in Britain," will be given by Dr. R. E. Mortimer Wheeler on November 24.

THE Academy of Medicine of Washington, D. C., will hold its fall dinner meeting on November 17. The program will be devoted to a "Symposium on Sulfanilamide." Dr. E. K. Marshall, of the Johns Hopkins Medical School; Dr. Sanford M. Rosenthal, of the National Institute of Health, and Dr. Frederick A. Reuter, of George Washington University Medical School, will be the speakers.

DR. FRANK B. JEWETT, president of the Bell Telephone Laboratories, New York City, was the principal speaker at a preview on November 5 held at the Rockefeller Center, New York City, of new exhibits at the New York Museum of Science and Industry. These included "The Story of Man" and "The Romance of Radium." The unveiling of a portrait of the late Henry R. Towne, who conceived the idea of the museum in 1924 and was one of its principal founders, was a part of the preview program. Other speakers were Dr. Haven Emerson, Dr. Louis I. Dublin, John H. Towne, son of the founder, and W. Gibson Carey, Jr.

THE American Society of Tropical Medicine will hold its thirty-third annual meeting at New Orleans from November 30 to December 3. The second Charles Franklin Craig Lecture on Tropical Medicine will be delivered by Dr. George W. McCoy, medical director of the U. S. Public Health Service, who will speak on "The History of Leprosy in the United States." Dr. Herbert C. Clark, director of the Gorgas Memorial Laboratory of Panama, will give the presidential address at the annual luncheon. He will speak on "Development of International Transportation and Its Effect on the Practice of Medicine."

THE annual fall meeting of the Pennsylvania Conference of College Physics Teachers was held at Pennsylvania State College on October 29 and 30. Representatives were present from thirty-six colleges, including fourteen from state teachers colleges. The total registration, exclusive of those from Pennsylvania State College, was one hundred and thirteen. Dr. F. K. Richtmyer, dean of the Graduate School of Cornell University, spoke on Friday evening on "Bricks, Mortar and Meter Sticks." Papers read and discussed on Friday afternoon included one each on "Training and Qualifications of Teachers of the Physical Sciences," "Education and Certification of Science Teachers," "Undergraduate Curricula in Engineering Physics" and the "Teaching of Physics in Teachers Colleges." The Saturday morning session was devoted to a panel discussion on the "Teaching of Physics and the Training of High-School Physics Teachers." Among those taking part in the program were Dr. Charles C. Bidwell, of Lehigh University; Dr. Thomas D. Cope, of the University of Pennsylvania; Dr. S. R. Powers, of Columbia University; Dr. J. K. Bowman, supervisor of secondary teacher education, Pennsylvania Department of Public Instruction, and Dr. Wheeler P. Davey, of the Pennsylvania State College.

THE fifth International Congress for Experimental Cytology will be held in Zurich, from August 7 to 12, immediately before the sixteenth International Physiological Congress and the International Veterinarian Congress to be held in the same place. The seven scientific sessions will be devoted entirely to symposia on the following subjects: epithelium in cultures and in the organism; structure of chromosomes; mechanism of mitosis; cancer cells and normal cells; experimental cytology and the study of viruses; ultrastructure of protoplasm and its products, and chemistry of the cell. On no occasion will the congress be divided into sections. Two afternoons will be devoted to demonstrations. Those wishing to take part in the symposia should submit their papers (with a summary not exceeding two hundred words) to Professor W. von Möllendorff, 9 Plattenstrasse, Zurich, before April 15. Copies of these papers will be distributed to members of the congress before the meetings. Further information may be obtained from Professor von Möllendorff, or from Dr. Harald Okkels, Institute for Pathological Anatomy, University of Copenhagen.

THE *Journal* of the American Medical Association reports that the *Queen of Bermuda* will sail from New York on January 15 for the seventh cruise congress of the Pan American Medical Association and will return on January 31. There will be five days of scientific meetings in Havana and stops will also be made at Port au Prince, Haiti; Trujillo City, San Domingo, and San Juan, Puerto Rico. All the countries to be visited have extended official invitations to the association to be their guests, and plans for entertainment are being made, according to the announcement. Chairmen of the sections of the association, which will hold meetings on shipboard as well as in Havana and in the other ports, have been announced as follows: Tropical medicine, Col. Charles F. Craig, New Orleans; Thoracic section, Dr. Jay Arthur Myers, Minneapolis; General medicine, Dr. Howard R. Hart-

man, Rochester, Minn.; Public health, Dr. Claude W. Munger, New York; Gynecology and obstetrics, Dr. Henry Dawson Furniss, New York; Orthopedic surgery, Dr. John Royal Moore, Philadelphia; general surgery, Dr. William D. Haggard, Nashville, Tenn.; Otorhinolaryngology, Dr. William E. Sauer, St. Louis; Cancer, Dr. James Ewing, New York; Radiology, Dr. Edwin C. Ernst, St. Louis; Urology, Dr. Elmer Hess, Erie, Pa.; Neurology, neurosurgery and psychiatry, Dr. Foster Kennedy, New York; Ophthalmology, Dr. Webb W. Weeks, New York; Dermatology and syphilology, Dr. Elmore B. Tauber, Cincinnati; Pediatrics, Dr. Orville E. Barbour, Peoria, Ill.; Physical medicine, Dr. William Bierman, New York; Industrial medicine and surgery, Dr. John B. Lauricella, New York; Dentistry, Alfred Walker, D.D.S., New York. Dr. Alberto Inclan, Havana, is president of the association, and Dr. Joseph J. Eller, New York, is director general.

THE United States Civil Service Commission announces open competitive examinations for which applications should be on file on November 29, for the position of associate meteorologist in the U. S. Weather Bureau, at a salary of $3,200 a year and of assistant meteorologist at $2,600 a year. To become eligible applicants must qualify in at least one of the following optional branches and must state in their applications the branch, or branches, desired: radiometeorography, air mass analysis, general and synoptic meteorology, physical and dynamical meteorology, statistical meteorology, any other well-defined specialized branch of modern meteorology. Further information can be obtained from the commission at Washington.

DISCUSSION

"GERM TRACK" AND "GERM TRACT"

UNFORTUNATE confusion exists in the use of the words "germ track" and "germ tract." If these expressions mean anything, they mean different things. A track is a path—a figurative one in this instance, down through time. A tract is a region, and could more or less properly refer to part of an embryo or of an individual in any stage. Neither one can by any legitimate stretch of language be used for the other.

"Germ track" was presumably first used in connection with the work of Weismann, as the English equivalent of his Keimbahn, of which it is a correct translation. It means the continuity of the germplasm through a line of descent, as contrasted with the intermittent or broken series formed by the somata produced in successive generations. How "germ tract" got its start would be difficult to ascertain. It may just possibly have originated as have the other biological expressions involving the questioned word, such as respiratory tract or optic tract. A plausible suggestion, however, is that it arose as a blunder resulting from a conversation or lecture in which the listener misunderstood the word and mistook the idea. Such an error might be confirmed by the other biological uses of the word tract, in the sense of a region. Having a familiar sound, and in these other places a legitimate use, the word tract could easily have been propagated so long as the original idea of a path was dissociated from it.

So far as the author is aware, the expression "germ track" is not being used in any other sense than genetic continuity. "Germ tract," on the contrary, is used in both senses. In one recent publication the words "germ tract" are followed by parentheses enclosing six other terms, which are presumably regarded as synonymous with or substantially equivalent to them. Two of these terms refer to continuity in descent, three of them to a region, while one is non-committal. Still another confusion has been discovered in conversation, though not in print, when the germ track was held to be the path followed by the germ cells in migrating from their point of "origin" to their ultimate location; in some animals such a track would be from the intestinal lining, through the mesentery, to the site of the gonads on the coelomic walls. This error is an isolated one, however, and not so likely to be repeated.

How best to eliminate the confusion into which the word "tract" has here fallen is suggested by the fact that it is not a very suitable name for the thing to which it is applied. "Tract" in its geometric sense means something drawn out, an area or an elongated form. Most of the biological uses of the word conform at least roughly to that idea, as feather tract, alimentary tract, etc. When it refers to something which has a considerable third dimension, there is often the excuse that anatomists have studied this object in sections where to the eye it is an area. The group of germ cells, or the region of an egg in which germ cells will be produced, is not aptly described by a word emphasizing extent. While one dimension of the germ mass may be less than the others, it is not often so much less as to suggest a surface. One would scarcely choose the word "tract" to describe such a mass, were it not for the fact that it had been used before. If, as is suggested above, the first use of "tract" in that sense was a simple error, prior usage is not a good reason for continuing it. Moreover, there are so many words which correctly describe the germinal region

that ineptitude in its name is scarcely to be condoned.

It would seem to be in the interest of clarity, therefore, to abandon the expression "germ tract" for both the abstract idea and the object to which it has been applied. It can not legitimately mean continuity, and it is not a good name for the germ mass. Surely, at least, no one with a feeling for language can go on using it for the continuity which the words "germ track" were used to describe.

A. FRANKLIN SHULL

UNIVERSITY OF MICHIGAN

UNITS IN MECHANICS

IN the recent text-book, "Mechanics," by W. F. Osgood, there appears in Section 11 of Chapter III a discussion of "Change of Units in Physics." The author is very definite and precise as to the method he proposes to use, but at the same time he vigorously denounces another method, viz., that of including units in the analysis. That Osgood has not seen the point to this method is very difficult to believe, but at any rate that is what is apparent from his criticism.

He states that to measure the length of right lines is to find how many times a right line chosen arbitrarily as the unit of length is contained in a given right line, and that the number, s, thus resulting is called the length of the line. Further, if s' is the length of a line in this sense when the yard is the unit and if s is its length when the foot is unit, then he shows by a proportionality that $s' = s/3$.

In a footnote he comments in part:

> It would seem paradoxical to say that the same *line* has a length of 6 when the foot is the unit and a length of 2 when the yard is the unit. But it must be remembered that the length is a function of two variables, the unit being one of them. The attempt is sometimes made to meet the apparent difficulty by saying "3 ft. = 1 yd." But this makes confusion worse confounded; for 3 = 1 is not true, while on the other hand to try to introduce "concrete numbers" like 3 ft., 10 lbs., 5 secs., into mathematics is not feasible. To try to change units in this way leads to blunders and wrong numerical results.

To illustrate this last claim he proceeds in a second footnote to find the relation between s' and s when the units are the yard and foot, respectively. He says "it would seem to follow from the statement (1 yd. = 3 ft.) that s' yds. = $3s$ ft. But $s' = 1/3s$. What a cheerful prospect of getting the right answer by that method!"

This is erroneous. From the notation he has adopted it follows that s' yds. = s ft., not $3s$ ft., as he suggests. Also, *in transforming an equation one can replace any term or quantity by its equivalent and the equation will remain true.* In the above equation, therefore, one may replace *yds.* by *3 ft.*, and the equation then becomes s' (3ft.) = s ft., whence $3s' = s$, or $s' = s/3$ as before.

So why the claim that there is confusion worse confounded? From the equation 3 ft. = 1 yd. there is no more reason for writing 3 = 1 than there is from the equation $3x = 2y$ for writing 3 = 2.

Evidently with Osgood a symbol or letter always signifies an arithmetical number. But why should it not be used to designate a *physical quantity*, or "concrete number" as he calls it? If s is the position of a point at time t (units included implicitly in both s and t) then ds/dt is the velocity (units included) at time t.

Furthermore, the statement "the length is 6" has by itself no meaning. To this Osgood would doubtless agree, for he states the length is a function of two variables, the unit being one of them. He thus must say, "the length is 6 when the ft. is the unit," or something similar. But the statement, "the length is 6 ft.," is only a shorthand way of conveying the same idea.

For the treatment of general theory in physical problems it is convenient to regard all symbols as including units implicitly. Then no mention of units need be made in developing equations. In applying developed equations to numerical problems one will never go wrong if when substituting for a symbol he puts in units as well as numerical measures, and in solving or reducing adheres to the principle of replacing units by their equivalents in other units. On the other hand, it is not *necessary* to operate in this way, for one may simplify matters by the use of a *homogeneous system* of units.

By a homogeneous system of units is meant: If in a general physical equation a set of corresponding values is substituted, units as well as measures, and if, with the units deleted, the resulting equation (in measures alone) remains true, then the units used belong to a homogeneous system.

This makes it possible to work as follows: If a homogeneous system of units is used in which to express the physical quantities occurring, the general equations developed may be regarded as relations among the measures only. The equations may be solved for the desired measures, and the results may then be stated physically by means of the system of units adopted.

Osgood uses Newton's second law with a proportionality factor, and in any given problem determines the value of the factor by the units being used. This is one possible way of dealing with units. Whether or not it is the best way is a matter of taste. But certainly there is no justification for the claim that to include units in analysis is to promote blundering.

J. W. CAMPBELL

UNIVERSITY OF ALBERTA

"FLYING" FISH

IN the western Atlantic, the Caribbean and the eastern Pacific I have observed flying fish with the help of Zeiss 7×50 binoculars from bridge heights of 30 feet and 68 feet. My observations are:

The fish fly very close to and parallel to the water surface. Sometimes they fly aboard gangways 3 feet above the water and rarely in heavy weather fly aboard a deck 12 feet high.

Flights are ordinarily straight, but one or two changes of ten or twenty degrees may occur.

Flights are ordinarily away from the ship or away from the fish, which are sometimes seen to leap from the water in chase of them.

The speed of flight apparently is uniform.

Flights are made in calm or moderately rough weather, though in the latter case flight sometimes seemed prematurely ended by collision with a wave in the way.

Actual emergence from the surface was rarely seen.

The parallel rows of double dots observed by Mr. Troxell[1] have been seen occasionally but not accompanying every flight.

Single flights were sometimes as short as a few yards, rarely as long as 150 yards.

Occasionally, especially when chased, the fish will make contact with the water with the lower part of its tail and by rapid sculling gain speed for further sustaining flight. This has been observed from a line of sight normal to the flight and was clearly seen as a bending downward of the tail to immerse the lower tip in the water, while the body kept its normal flying angle approximately parallel to the water. Viewed from behind and above, the sculling trace in the water is a beautiful sine curve whose amplitude to one side of the median is about equal to 180 degrees of the cycle. The trace may be from a yard to ten yards long.

G. B. MYERS
LIEUTENANT COMMANDER, U. S. NAVY

"FLYING" SALMON

ANENT "Again Flying Fishes."[1] Comparative vology may give light. The gurnard family is handy in movements. We see some of them walking on the floor of aquariums, but when a flying gurnard has not secured enough momentum and velocity for a flat trajectory over waves we see it descending and submerging the caudal fin only for a fresh start instead of using the pectorals as a bird would do. I photographed a series of salmon "flying" as much as eighteen feet in the air when surmounting a fall in the White Bear River in Labrador. They employed the pectoral fins as well as the caudal for progression and balancing in air as well as when in water. I have suggested to a friend that he take such pictures with his moving picture camera. These may be taken at a few yards distance instead of at a disappearing distance first.

ROBERT T. MORRIS
STAMFORD, CONN.

QUOTATIONS

LORD NUFFIELD'S NEW GIFTS TO OXFORD

AN Oxford that had made up its mind not to be surprised by Lord Nuffield's almost daily giving to hospitals and other institutions was agreeably staggered last week to learn that the university had been offered by him approximately £1,300,000 for three important purposes. The first of these is the erection and endowment of wards in connection with the Radcliffe Infirmary and the other hospitals associated with the School of Medicine, particularly the wards for the special use of the new Nuffield professors. The sum promised for this is £200,000, so that Lord Nuffield's endowment of the medical school within the past twelve months amounts to the munificent sum of £2,200,000. The second is the erection of the new laboratory of physical chemistry on a site between the Organic Chemistry Laboratory and the Department of Pathology in South Parks Road. For this a sum up to £100,000 is promised. The third and, to the general public, the most interesting, is the founding and endowment of a new college for post-graduate work in social studies, to be erected near Worcester College on the canal wharf that lies below St. Peter's Hall. For this, Lord Nuffield has given the valuable site itself, and a sum of about £900,000, about £250,000 of which will be required for the buildings.

The Oxford appeal launched last February aimed at £500,000 for definite and immediate needs, and a further £500,000 for the endowment of new developments in any subject that looks promising. It has now reached the sum of £423,000. As the physical chemistry laboratory is one of the immediate needs, this sum now becomes £523,000, and so as regards these needs the appeal has been successful. The first major step in the ordered development of the science area in the Parks has accordingly been taken—to proceed with the erection of the new physics laboratory for Professor F. A. Lindemann at a cost of about £80,000; and soon will follow the second, for which already provisional plans have been prepared—the erection and equipment of the university's first laboratory for physical chemistry with the sum given by Lord Nuffield, and the sums earmarked for it in the appeal fund.

[1] SCIENCE, 86: 2225, 177, August 20, 1937.

[1] SCIENCE, August 20, 1937.

The great majority of senior members of the university welcome these gifts as, of course, they deserve to be welcomed. A few complain that they will alter the character of the university considerably and, probably, for the worse; a few wish the offer had been entirely unconditional or, alternatively, that their own department or subject had been in the position of medicine, physical chemistry or social studies. As regards the last, it is realized that the success or failure of the new college will depend much on the start it gets and, in particular, on the first warden and fellows. A long and carefully drafted letter from Lord Nuffield to the Vice-Chancellor gives some ideas of the intended college and its fellows, and others have been got from some of the principal Oxford men who are concerned. The new college is to be mainly a post-graduate one, like All Souls', with accommodation for, say, fifty residents, and principally for research and investigation. It need not be entirely devoted to social studies; other subjects may be considered. It is not intended that it be a teaching institution in the ordinary sense or that it should train undergraduates for business careers, still less that it should be a place where the newly graduated may start to research according to their fancy. It is hoped that the fellows will be mature workers, brought back after they have been out in the world for some years, to do large-scale team work on those social subjects on which research is urgently needed. The new college, it is hoped, will not merely be a center for these activities in economics, politics, anthropology, sociology and the like, but also a place where men of business and affairs, by residing there, will have an opportunity of contributing their experience to the common fund. This cooperation of academic and non-academic persons in attacking problems in the social sciences is regarded as valuable by those who, with Lord Nuffield and the Vice-Chancellor, have been thinking of the welfare of the new college. It remains to be seen how Oxford makes use of these gifts, which bring, of course, their difficulties and responsibilities with them. That it will rise to the occasion no one who knows the temper of young Oxford at the present time will question.—*Nature.*

SCIENCE AND DEMOCRACY

YOUR recent editorial "Science and Democracy" begins with the words "Science as we know it is the child of democracy." From the point of view of a man of science the family relationship is here reversed: Democracy is the child of science. I quote from a convocation address with the same title as your editorial given at the University of Indiana in 1912:

> Without science our present civilization would not have been possible. It is the application of science to commerce and the arts that has created democracy. So long as food, clothing and dwellings were produced and transportation carried forward by unaided manual toil, so long as plague and famine, disease and premature death, were unchecked, it was impossible to give equal opportunities to all. Plato had to provide slaves for his republic; serfs and peasants have been partly emancipated only in our own time. It is the applied science of the past hundred years that has made child labor needless and universal education possible, that has made the still existing semi-slavery of industry wanton and intolerable.

You call attention to the proposal made in England that the British and American Associations for the Advancement of Science unite to draft "a magna charta, a declaration of independence," proclaiming that freedom of research and of exchange of knowledge is essential, and add, "Will the American association heed the appeal of its British counterpart?" At its meeting in Boston in 1933 the American association adopted the following "Declaration of Intellectual Freedom":

> The American Association for the Advancement of Science feels grave concern over persistent and threatening inroads upon intellectual freedom which have been made in recent times in many parts of the world.
>
> Our existing liberties have been won through ages of struggle and at enormous cost. If these are lost or seriously impaired there can be no hope of continued progress in science, of justice in government, of international or domestic peace or even of lasting material well-being.
>
> We regard the suppression of independent thought and of its free expression as a major crime against civilization itself. Yet oppression of this sort has been inflicted upon investigators, scholars, teachers and professional men in many ways, whether by governmental action, administrative coercion, or extralegal violence.
>
> We feel it our duty to denounce all such actions as intolerable forms of tyranny. There can be no compromise on this issue, for even the commonwealth of learning can not endure "half slave and half free." By our life and training as scientists and by our heritage as Americans we must stand for freedom.

J. MCKEEN CATTELL, *in the New York Times*

SCIENTIFIC BOOKS

ASTRONOMY

Text-Book on Spherical Astronomy. By W. M. SMART. Published January 5, 1937, in Cambridge: At The University Press, in New York: by the Macmillan Company. $5.50.

A HUNDRED years ago the only physical character-

istic of the stars which was observed, the brightness, merited only a brief paragraph in the text-books. Attention was directed almost entirely to problems of spherical astronomy and dynamics. In contrast the great majority of modern books and papers deal with problems in astrophysics, stellar statistics or stellar dynamics. The newer topics receive this attention because they promise more rapid progress and the application of many new branches of knowledge. The older problems of position astronomy are no less important to-day than formerly. In fact, they are even more important, since through them are defined the fundamental reference systems used in many of the other analyses. As a result of this change of interest very few modern books on spherical astronomy are published and it is a pleasure to call attention to an excellent discussion of this field.

The second edition of Dr. W. M. Smart's text "Spherical Astronomy" is nearly identical with the first. In addition to the standard topics of spherical astronomy discussions are included of planetary motions, heliographic coordinates, star positions by photography, binary star orbits and occultations and eclipses. These additional chapters are of especial value, for the topics covered have seldom been discussed in texts or at best only partially considered. As in the first edition numerous clear illustrations are found throughout the book. A few errors in the text have been corrected, and three new appendices have been added. These treat the "Method of Dependences," "Stellar Magnitudes" and the "Coelostat." The first and third of these appendices are satisfactory, although some comment upon the relative accuracy of the "Method of Dependences," and the standard form of reduction could have been added with profit. The brief appendix on "Stellar Magnitudes" seems unnecessary in as much as magnitudes are not discussed anywhere in the text. It is unfortunate that the orbital elements of Pluto listed in Appendix C were not revised, for more precise orbits have been derived since 1931.

"Spherical Astronomy" deals only with the mathematical solutions of various problems. No attempt has been made to evaluate the relative advantages of the different solutions presented. Thus the author avoids controversy, but the reader is forced to rely upon some other source for aid in discrimination. This situation could have been partially remedied by more complete references to the original papers from which some of the analyses were drawn. The relations between the specific problems and the general problems of fundamental astronomy are not considered, and wisely so, for the book is designed as a text of working methods, not as an essay on problems in astronomy. For these reasons the book should be studied in the classroom or by students who have some general knowledge of the problems considered.

As a concise discussion of the solution of various problems in spherical astronomy Dr. Smart's book has no superior. It should be in the library of every serious student of astronomy, whether beginner or professor.

FLETCHER WATSON, JR.
HARVARD OBSERVATORY

SEISMOLOGY

Introduction to Theoretical Seismology, Part I, *Geodynamics.* By J. B. MACELWANE, S.J. New York. Wiley, 1936. x + 366 pages. $6.00.

SEISMOLOGY — the science of earthquakes — has grown out of its infancy in this country during the last decade or so. The graduation is fittingly marked by the publication of the first considerable text- and reference book on the subject in English.

The author has spared no pains to write a full and elementary account of the subjects treated. The classical theory of waves in an elastic solid is well presented in the first five chapters. Chapter VI, written by F. W. Sohon, S.J., treats the elements of the theory briefly by the methods of vector analysis. Chapter VII contains a beautifully written discussion of the methods of Zöppritz and Knott on the energy relations involved in the reflection and refraction of elastic waves.

The first part of Chapter VIII is not quite so clear. The effort to give an elementary account of the integral equation has involved the introduction of so much notation that the essentials of the theory are somewhat concealed, so that, for example, the equation of the Volterra type is spoken of as a Fredholm equation. The treatment is of course correct, nevertheless, although some improvement in detail could be effected, such as the abandonment of Simpson's rule in favor of better methods of quadrature. The later parts of this chapter present a summary of the important results on the interior of the earth which have been obtained in recent years by Macelwane and his co-workers. The schematic section of the earth as obtained by Dahm, pictured on page 227, is most interesting, and illustrates the rapid changes that are taking place in our conception of the interior of the earth.

The last three chapters treat the interpretation of seismograms, the determination of epicenters, and the problems of depth of focus. These chapters and the tables and curves will be very helpful to the practical seismologist, who still meets many puzzles in the task of unraveling the complex messages on his seismograms.

The theory of seismic waves is not an easy subject, and a very effective effort has been made to bring it

within the reach of students who are unacquainted with mathematics beyond the calculus. But such students are not yet properly prepared to enter a subject like theoretical seismology. By presuming on a little more acquaintance with the powerful mathematical tools that are available the author could have greatly shortened and simplified the treatment of elastic waves. For example, the set of equations at the top of page 30 would be replaced by the shorter and easier statement that the matrix A is a diagonal transform of X by the orthogonal matrix l, and the reductions in Sections 68 and 69, which must appear very fortuitous to the student, would be presented as an application of a general theorem on the decomposition of a vector field into solenoidal and irrotational components. There would then be space for such topics as the work of Uller, Sezawa, and others on seismic waves, the method of Pekeris, a comparison of the travel-time curves of Jeffreys, Wadati, Gutenberg and Richter, and Macelwane, and a study of the earth's core, for which no satisfactory theory has yet been given. A discussion of these subjects written in as clear a style as the rest of the book would be most welcome to workers in seismology.

ARCHIE BLAKE

U. S. COAST AND GEODETIC SURVEY

THE NATIONAL ACADEMY OF SCIENCES

ABSTRACTS OF PAPERS[1]

Measurement of solar radiation from high altitude sounding balloons: BRIAN O'BRIEN, L. T. STEADMAN and H. S. STEWART, JR., introduced by Charles G. Abbot. Light received by a crushed quartz diffuser, with circular entrance aperture lying in horizontal plane when instrument is suspended at rest, reaches vacuum photocell mounted beneath diffuser with filter selecting desired spectral region. Identical area of photocell surface is illuminated irrespective of angle of incidence of solar beam. Photocurrent discharges condenser which on recharge causes radio transmitter to emit short dash. Frequency of dashes is proportional to light incident upon photocell. If instrument is suspended at rest with Sun at zenith angle z, the light intensity incident upon photocell is $I_h = k\ I_o \cos z$ where $I_o \equiv$ intensity of incident solar beam and $k \equiv$ instrument constant. An instrument suspended from a rising balloon swings as a conical pendulum of varying amplitude and ellipticity. For circular motion at half angle α the average intensity received by the photocell through one complete swing is $I = k\ I_o \cos z \cos \alpha$, the instantaneous values varying from $k\ I_o \cos (z-\alpha)$ to $k\ I_o \cos (z+\alpha)$. Since ten or more radio signals are transmitted during one complete swing and interval between any pair provides measure of intensity these yield directly the amplitude of swing and permit calculation of I_o from observed values of I.

Test flights made above 20 km exhibit good radio performance to 80 km distance. Instrument swing observed by telescope agrees with amplitude determined from radio signals. Complete unit weighs 1 kilogram including batteries for three hours operation. Laboratory tests indicate response is reproducible to one part in 200. Circuit is self-compensating for fluctuation in battery potential. It is hoped that a precision in radiation measurement of the order of 1 per cent. may be maintained on an absolute scale, but further refinements are needed before this can be assured.

Regulation of heat loss from the human body: JAMES D. HARDY and EUGENE F. DU BOIS. Experiments have been performed on two normal men to study the regulation of body heat loss when exposed nude to environments ranging from 22° C. (72° F.) to 35° C. (96° F.). In the temperature range from 30° C. (87° F.), to 32° C. (91° F.) the body eliminated a minimum amount of heat, and this was equal to the basal heat production. Beyond the range of this neutral zone, either in hotter or colder environments, the heat elimination from the body increased. In atmospheres of 32° C. or higher the skin temperature changed but slightly and regulation of body temperature was brought about by increased vasodilatation and sweating. The mechanism in this range is so sensitive that a 2° C. (3.6° F.) change in environmental temperature will increase the sweating about 50 per cent. and the peripheral blood flow about 20 per cent. The effect of forced air currents from an electric fan were studied. In the temperature range from 28° C. to 30° C. the increased convection caused considerable loss of heat and fall of skin temperature. At 32° C. (91° F.) the turning on of the fan caused an immediate but temporary slight fall in the skin temperature. The cooling effect of an electric fan at these summer-like temperatures lasts only a few minutes. Automatic regulation of body heat loss is effective down to 29° C., which is the low temperature portion of the neutral zone. At this point the thermal gradient, the difference between the skin and surroundings, is 4.7° C., and this is the maximum gradient at which the body can maintain its temperature. Thus as the environmental temperature is dropped the skin should cool in such a manner as to keep this gradient constant, if body heat is to be preserved. Actually the skin drops at only half the rate of the environmental temperature, and the heat from the body is not preserved. The question arises as to whether this cooling of the skin is the result of some physiological reaction of the body (even though incomplete) or of the fall in environmental temperature. As has been presented by Hardy, the conductance of the peripheral tissues in this range is constant, so that there is no evidence of significant physiological reaction. The drop in surface temperature is due to the fall in environmental temperature just as in the case of any warm inanimate object. The body cools until some mechanism, as yet undetermined, causes the onset of a chill. The muscular activity thus brought about causes a large rise

[1] Continued from the issue of SCIENCE for November 5.

in heat production and a consequent rise in skin and internal temperature. With this rise the chilling ceases and the subject remains comfortable for an hour or so before another paroxysm. The metabolism of the subjects was basal almost to the onset of the chill, and no increase in oxygen consumption was observed except as accompanied by "tensing" of the muscles or the spasmodic muscular contraction of shivering. No evidence of Rubner's "chemical regulation" was observed.

The physical laws of heat loss from the human body: JAMES D. HARDY (introduced by Eugene F. Du Bois). Using a large respiration calorimeter, a comparison was made between the heat loss from two nude men and that lost from a blackened cylinder (artificial man) filled with water whose temperature could be controlled. Of the two men studied the larger lost more heat than the smaller, but on the basis of the total surface areas the heat losses were the same. These men lost almost exactly the same amount of heat by radiation and convection as the artificial man per degree difference in the temperature of the surfaces of the air. The proportion of losses between radiation and convection were almost identical. In the case of the men it was of course necessary to subtract from the total the heat lost in vaporization of moisture, about 24 per cent. It was also necessary to allow for the fact that the surfaces between legs and under the arms, etc., do not lose heat by radiation and convection. The effective surfaces of their bodies concerned in the loss of heat calculated from a comparison with the artificial man came to 79 per cent. of the total surface areas. Calculated by photography and actual measurements the values were 78 per cent. to 80 per cent. As soon as the men moved the heat lost in convection was increased and the surface temperature dropped, causing a decrease in radiation. More heat was eliminated through the cooler skin than had been eliminated through the warmer skin. This apparent contradiction of Newton's cooling law had been observed by Barr and Du Bois in the shivering periods of malarial chills. The explanation of the paradox lies in the increase in convection, which is not necessarily dependent on the differences in temperatures. It is possible from such observations to measure the thermal conductance (or what is the same thing, the blood flow) of the peripheral tissue. Body tissue, itself, is highly insulating, and the heat from the internal organs may be considered as being carried to the skin by the blood stream. If the internal (or rectal) temperature, the heat eliminated and the average skin temperature be measured, it is possible to calculate the relative flow of blood to the peripheral tissues. In warm atmospheres 34° C. (94° F.) the blood flow is about three times as large as the rate at 28° C. As the environment is cooled the blood flow decreases to a minimal rate at 28° C. (83° F.) and remains at about this level, even though the environmental temperature drops to 22° C. (72° F.), at which point the subject will shiver in a relatively short time. This means that vasomotor adjustment in man is limited largely to the high temperature range and that vasoconstriction at lower temperatures plays a minor rôle in insulating the body against cold.

Rates of adjustment of body water content: E. F. ADOLPH (introduced by L. J. Henderson). Water balance may be described by correlating rates of water intake and output with the water contents of the organism. Such relationships are illustrated by data for dog and man. In normal dog and man, water exchanges were measured in initial periods after the water content had been either increased by introducing water into the stomach or decreased by periods of water privation. In a dog provided surgically with esophageal fistula, so that drinking could be measured without the water drunk gaining access to the body, rates of intake were ascertained also during steady states of desiccation. At diverse water contents, output varied markedly by only one path, namely, urine formation; and gain varied by one path, namely, ingestion. The rates of intake and of output were equal at only one water content, namely, the usual one. Whenever the content of water was experimentally modified, it returned rapidly to this usual content; in deficit by faster net gain, in plethora by faster net loss. The two species showed quantitative differences in urine outputs as related to body weights. In half an hour, dogs fully made up any water deficits, but men ingested only one third to two thirds of the water required. Similar correlations of rates of adjustment with states of deficit and plethora have been made for other species and parts of organisms, and for other substances, energies and forces. Each describes quantitatively a kinetic equilibrium by which a constancy is reattained after displacement.

Studies of water metabolism in pregnant women: W. T. POMMERENKE (introduced by Carl G. Hartman). Visible edema, inordinate gain in weight and suppression of urinary output provide crude evidence of water storage in certain toxemias of pregnancy, notably in the convulsive state of eclampsia. It has been suggested that the convulsions of eclampsia and certain other symptoms of toxemia of pregnancy are due in part to this excessive water storage. To what extent the alleged deposition of water also relates to normal pregnancy is not so clear and forms the basis of this study. Water made available to the organism comes from that ingested as such, or with food, and that liberated as a result of metabolism. The water output represents in addition to the obvious water in the urine and stools that lost through the skin and lungs which can be estimated by indirect methods, depending on the metabolism of the individual. The algebraic sum of water made available to and that lost from the body represents the water balance. Controlled experiments on 3 pregnant women over periods from 5 to 12 days demonstrated storage of water. This observation was confirmed by studies of electrolyte balances and concentration of bases in the blood, the assumption being that such bases are lost by the body in about the same proportions as they appear in the plasma.

Oxidation of the phospholipids: W. R. BLOOR (introduced by G. H. Whipple). It had previously been found that oxidized phospholipid could transfer oxygen to reduced methylene blue at body pH (7.4). Attempts were

made to use it to oxidize dextrose under the same conditions. The attempts were without success even when air or oxygen was passed through the solution. It was observed, however, that the pH of the solution was lowered, which indicated that some oxidation had taken place, presumably in the phospholipid. The amount of oxidation was not great. Oxidation of phospholipid was then attempted with hydrogen peroxide at 37° C. and pH 7.4. Purified brain lecithin and cephalin were suspended in neutralized 30 per cent. hydrogen peroxide and kept at 37° C. for 24 to 48 hours. The solutions were then extracted with ether and the extracts analyzed. It was found that under these conditions about 75 per cent. of the lecithin had disappeared but only about 25 per cent. of the cephalin. The residue from the cephalin consisted largely of insoluble material, while that from the lecithin resembled the original lecithin, although the iodine numbers of the fatty acids had been greatly reduced. The products of the oxidation consisted largely of carbon dioxide and volatile acids the nature of which has not yet been determined.

A chemical study of the balance sheet of fat absorption in the rat: MATHIAS F. F. KOHL (introduced by D. D. Van Slyke). Balance sheet studies on the absorption of elaidic acid, the stereo-isomer of oleic acid, have been carried out on male rats weighing approximately 100 grams. The studies were made over hourly and daily absorption periods using two dietary régimes, the feeding of elaidin as the sole food source and as 40 per cent. of the caloric intake. The rates of absorption and disappearance of the absorbed elaidic acid are different under the two régimes but are found to be relatively continuous and constant. When elaidin alone is fed, most of the absorbed fat is apparently consumed in the vital processes of the organism with the deposition of only a small part of the absorbed fat. When ample protein and carbohydrate are supplied along with the elaidin, the amount of the absorbed fat disappearing is markedly reduced with a consequent greater storage of ingested fat. Elaidin when once deposited in the adipose tissue disappears at a slow rate; over thirty days are required to clear the depots of the elaidic acid that is deposited when elaidin is fed over a three-day period as 40 per cent. of the caloric intake. The conclusion is drawn that the elaidin that is continually being absorbed from the intestine is used to supply the energy requirements of the tissues for fat. This demand is reduced by an ample supply of protein and sugar which the cells catabolize preferentially to fat. The absorbed fat in excess of this cellular demand for fat is removed from the circulation into the fat depots, where it remains as a relatively inert deposit until periods of under-nutrition, when it is called forth again to supply the metabolic needs. Definite regulatory mechanisms of fat metabolism are in evidence, but nothing is known of their nature.

Experimental diabetes insipidus: ROWLAND T. BELLOWS and WILLIAM P. VAN WAGENEN (introduced by Harvey Cushing). Diabetes insipidus is generally considered to be an abnormally increased secretion of urine. There are other phenomena observed in the disease, however, which have been largely ignored. These suggest that it is a fundamental disorder in the water metabolism, in which the abnormally increased thirst, or polydipsia, is of prime consideration. In the experimentally produced disease in dogs the water intake appears to govern the amount of urinary output, and when the water intake is restricted the animals appear to remain in water balance. Dogs with diabetes insipidus gain weight and become obese when their thirst is satisfied, but fail to do so when the water intake is restricted to the normal amount. When diabetes insipidus is produced in dogs with fistulae of the esophagus, it is found that the animals continue to be thirsty, even though they are maintained in water balance by the administration of water per esophagus. These considerations suggest that the excessive thirst plays the leading rôle in diabetes insipidus rather than the polyuria and that the satisfaction of the polydipsia leads to the chronic retention of water. Two forms of diabetes insipidus are generally recognized—temporary and permanent. Our studies reveal a peculiar relationship between them. They appear to possess different characteristics than mere duration and to depend upon a different type of injury in the pituitary region for their production.

Biographical Memoir of Edward Salisbury Dana: ADOLPH KNOPF. (Read by title.)

Biographical Memoir of Edwin Brant Frost: OTTO STRUVE. (Read by title.)

Biographical Memoir of Robert Simpson Woodward: F. E. WRIGHT. (Read by title.)

SPECIAL ARTICLES

ANTIRABIC IMMUNIZATION WITH CULTURE VIRUS RENDERED AVIRULENT BY ULTRA-VIOLET LIGHT

PREVIOUS investigators have shown that rabies and poliomyelitis viruses, among others, may be rendered avirulent by ultra-violet light.[1] But reports in the literature indicate that a virus thus made avirulent is unable to immunize animals against a test inoculation; according to these experiments, immunizing potency is retained only when virulence has not been completely destroyed.

Evidence is presented in this communication showing that rabies virus may be exposed to ultra-violet

[1] G. Sankaran and W. A. Beer, *Indian Jour. Med. Res.*, 22: 581, 1935; John E. Gordon and Thomas P. Hughes, *Jour. Immunol.*, 30: 221, 1936; J. A. Toomey, *Amer. Jour. Dis. Child.*, 53: 1490, 1937.

light in such a way that its virulence may be destroyed without complete loss of its immunizing power.

Thirty cc of clear rabies culture virus,[2] containing 33,000 mouse intracerebral lethal doses per cc, were placed in a quartz flask 12.5 cm from a quartz mercury vapor lamp. The intensity of the ultra-violet light was measured by means of a photronic cell and filter. During the period of irradiation the temperature of the virus was kept at 23° C.

The virus was irradiated 45 to 60 minutes and then tested for virulence by injecting 0.03 cc intracerebrally into each of eight or ten mice. The immunizing potency of the irradiated virus was determined[3, 4] by vaccinating mice each with 0.25 cc intraperitoneally. In all, six vaccinating doses were given, one every other day. About 3 weeks later the immunity of the vaccinated mice was tested by injecting each of them intracerebrally with 0.03 cc of mouse-brain rabies fatal dose of test virus, as contrasted with only one of 19 vaccinated mice; 12 of 12 unvaccinated mice died after inoculation with 10 fatal doses, as contrasted with 3 of 11 vaccinated mice; and 8 of 8 unvaccinated mice succumbed to 100 fatal doses, as contrasted with 2 of 8 vaccinated animals. These differences are significant according to the χ^2 test, $P = < .01$.

Further experiments showed that culture virus irradiated only 30 minutes immunized well but remained virulent to a slight degree, while virus irradiated 2 hours became inert both as to immunizing potency and virulence. Finally, culture virus in a glass flask, wrapped with tinfoil, which is impervious to ultra-violet light, and exposed to the mercury vapor lamp for 2 hours, showed no loss of virulence.

It is concluded, therefore, that rabies culture virus, exposed to a proper dose of ultra-violet light, becomes avirulent and yet retains enough of its immunizing power to protect mice against 10 intracerebral lethal doses of test virus.

TABLE I

IMMUNIZING POTENCY OF IRRADIATED, NON-VIRULENT RABIES CULTURE VIRUS

Treatment of culture virus	Virulence following irradiation	Fate of mice receiving test virus					Protection afforded by vaccination in minimal lethal doses
		Mice	Dilutions of virus				
			10^{-4}	10^{-5}	10^{-6}	10^{-7}	
Test 3							
Irradiated		Controls	...	4/4†	2/4	1/4	
60 minutes	None 0/8*	Vaccinated	...	0/3	0/3	...	10
Test 4							
Irradiated		Controls	4/4	7/13	1/4	...	
45 minutes	None 0/8	Vaccinated	0/4	1/8	...	...	10
Test 5							
Irradiated		Controls	4/4	4/4	3/4	1/4	
45 minutes	None 0/10	Vaccinated	1/4	2/4	0/4	0/2	10
50 minutes	None 0/10	Vaccinated	1/4	1/4	0/4	0/4	100

* 0 of 8 injected mice succumbed.
† 4 of 4 injected mice succumbed.

virus. Some received 1,000 lethal doses, some 100, some 10 and some one lethal dose of the test virus. Unvaccinated mice of the same age received like amounts of the virus, respectively.

These experiments (Table I) show that the irradiated, avirulent culture virus immunizes against 10 or more intracerebral lethal doses of test virus. In each experiment, taking one fatal dose as the greatest dilution killing 50 per cent. or more of the unvaccinated mice, it appears that 10 to 100 times this dose was withstood by 50 per cent. or more of the vaccinated mice. Combining results of the three tests, it is noted that 12 of 21 unvaccinated mice succumbed to one

[2] L. T. Webster and A. D. Clow, *Jour. Exp. Med.*, 66: 125, 1937.

[3] L. T. Webster, *Amer. Jour. Pub. Health*, 26: 1207, 1936.

[4] L. T. Webster, *Amer. Jour. Pub. Health*, 1937 (in press).

The technique described above is being further developed and applied.

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CHANGES IN HUMAN BRAIN POTENTIALS DURING THE ONSET OF SLEEP

WHEN a person goes to sleep, the pattern of his brain potentials alters systematically. Five clearly defined stages have already been described[1] as follows:

A—*alpha:* the normal waking 10-per-second rhythm
B—*low voltage:* the alpha rhythm is lost
C—*spindles:* short groups of 14-per-second waves ap-

[1] A. L. Loomis, E. N. Harvey and G. Hobart, *Jour. Exp. Psychol.*, 21: 127, 1937.

pear and also random "delta" waves 0.2 second or more in length

D—*spindles plus random:* both types of wave increase and the delta waves become longer

E—*random:* the spindles become inconspicuous, but delta waves continue to increase in voltage and wave-length

We have now investigated the finer details of the *A* and *B* stages, and are able to relate alterations of the pattern to changes in the subject's state of consciousness.

The subject lies down to sleep with a rubber bulb in one hand, and is instructed to squeeze it once whenever he feels that he has just "drifted or floated off" for a moment and twice if he feels that he has awakened from "real sleep." As the subject becomes drowsy, the alpha waves (if he has them normally) diminish in voltage, and interruptions of their rhythm are more and more frequent. The interruptions become longer and more complete, and when one of them has lasted for 5 seconds or thereabouts, with the low-voltage record characteristic of the *B* state, the subject usually signals "have floated." The alpha waves usually return a second or two before the signal. With the first long break in the sequence of the alpha waves, we often see a measurable decrease in delta activity (see Fig. 1). The delta waves are best recorded from the top of the head. In persons who have very little alpha rhythm when awake, the appearance of these relatively short (0.2 to 0.25 second) low-voltage (75 microvolts) delta waves may be the first clear change in the record.

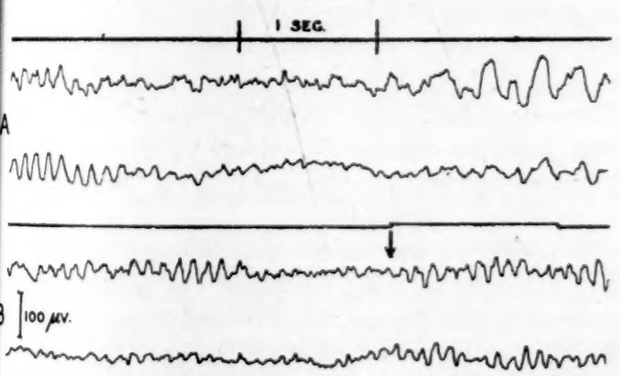

FIG. 1. A—Subject falling asleep. Upper line, vertex to ear; lower line, occiput to ear. B—A brief "float," signalled at arrow.

If the delta waves have reached 150 microvolts and have persisted for half a minute or more, the subject may signal "real sleep" when he next awakes. The still deeper *C* stage, with its spindles, is unquestionably "real sleep." The transition from the intermediate "floating" stage to "real sleep" apparently occurs somewhere in the *B* stage.

The transition from *A* (waking) to *B* ("floating" or sleep) is not simultaneous in all parts of the brain. The alpha waves may be suppressed and the delta waves appear in one part while the alpha rhythm continues normally in another region (see Fig. 1). On such occasions the subject may report that he has been fully conscious. This condition merits further study, for apparently different parts of the brain may "go to sleep" separately and to different degrees. It makes quite meaningless any question as to the exact moment at which a person falls asleep.

The data of Table 1, based on two subjects, are broadly typical of the whole group, particularly as to the prolongation of the "floats" as sleep approaches. The interval between the return of alpha waves and the signal varies and may sometimes be as much as 5 seconds. It is interesting, however, that occasionally the signal is given just *before* the alpha waves return.

TABLE 1

Subject*	Signals	Average time between signals	Average duration of depression of alpha waves before signals	Average time from return of alpha waves to signal
A	1–5	16.9 sec.	2.9 sec.	0.2 sec.
	6–10	12.1 sec.	4.1 sec.	0.2 sec.
	11–15	17.8 sec.	7.8 sec.	0.4 sec.
	16–20 (sleep)	20.5 sec.	13.5 sec.	0.3 sec.
B	1–3	30.2 sec.	6.2 sec.	2.4 sec.
	4–6	37.8 sec.	10.4 sec.	2.6 sec.
	7–9 (sleep)	36.2 sec.	22.7 sec.	1.1 sec.

* Subject A fell asleep after his 20th signal, subject B after his 9th. The grouping of the signals by five's and three's for obtaining running averages is entirely arbitrary.

The accuracy of the signalling is remarkable, considering how unfavorable drowsiness is for introspection and signalling. In 9 experiments 6 subjects who have strong alpha rhythm when awake signalled "have floated" or "have slept" 165 times. All but 6 of these signals were preceded by definite depressions of the alpha waves. The records show only 39 similar depressions which were not signalled.

Two subjects who have very few alpha waves when awake showed partial depressions of their own characteristic quick waves and often increases of delta activity which correlated very well with their signals.

Only one subject gave signals which showed no constant relation to alterations in his brain potentials. The results of his tests are not included in the figures above, and we have also omitted three preliminary experiments and two in which the subjects were "asleep" most of the time and often failed to signal when a few seconds of alpha waves appeared on the record. In this condition the subject apparently does not rouse himself sufficiently to give the signal.

The common denominator in the subjective reports of the experience of "floating" is a depression of sensory perception. Some identify the state by suddenly realizing that they have ceased to hear noises or that they have lost their awareness of the bed clothes or the position of their body. Others stress the appearance of visual fantasies or interruptions in the train of logical thought, but in all cases there is loss of awareness, particularly for immediate external stimuli. This transient depression of consciousness appears to be correlated with definite objective alterations in the electrical activity of the brain.

We may summarize the initial stages of sleep as follows:

A —*alpha:* at rest but awake.
B_1—*low voltage, alpha rhythm lost:* intermediate drowsy or "floating" state.
B_2—*low voltage, delta waves appearing:* intermediate, merging into sleep.
C —*spindles and moderate delta waves:* real sleep.

Two practical points are important for clinical electroencephalography. First, the drowsy state must be strictly avoided when determining the amount of alpha or of delta activity which is characteristic of a given subject. Second, the electrical patterns of early sleep strikingly resemble those which we have seen in some patients who are psychotic or otherwise abnormal. We must not be misled in diagnosis by an unsuspected dozing or "floating off" of the patient during a test. On the other hand, many abnormal conditions may prove to depend upon general modifications of function which are fundamentally similar to those of normal sleep. We are now investigating this possibility.

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TREATMENT OF THE R_{39} RAT SARCOMA

DURING the past year, a study has been made of some new methods of treating animal tumors. These experiments are not completed. However, they have led to another approach, the use of which has a definite influence on the growth of the tumors and which will be described in this communication. All the work was done with rats which had been inoculated with the R 39 sarcoma.

Iron, in various forms, had been employed in the other experiments. Because of the peculiar carbohydrate metabolizing qualities of malignant tumors, it was decided to administer a combination of iron with sugar. For this reason ferric gluconate was made. It was discovered that ferric gluconate alone had some power to impede the growth of tumors. However, only 12 of 36 animals so treated showed this response.

The principle of double injections which, as far as we know, has not been used before, was therefore tried. In view of the fact that some animal tumors take up injected dyes readily, it was planned to administer either neutral red or azo blue intraperitoneally, and to follow this injection with an intravenous one of ferric gluconate. The hypothesis was that the dye might make up a chemical bed in the tumor, by virtue of which the ferric gluconate might either be held in increased quantity, or be made more effective, in the tumor. Various dosages and changes in the intervals between the two injections were used. The results were striking. Of 64 animals so treated 47 (73 per cent.) showed that the growth of the tumor had been sharply influenced. In all 47 instances the tumor stopped growing; in roughly half of the cases it receded. Cessation of growth always occurred in close association with the administration of the ferric gluconate. For example, in 31 instances the dye was given daily for two or three days, the first ferric gluconate administration not being given until a day or two after the last dye injection. In the 23 cases of this group in which there was an effect, stoppage of growth occurred regularly within 24 hours of the giving of the ferric gluconate. Ferric gluconate has proved to be either non-toxic or only slightly so. There have been some deaths, but the facts indicate that these are not from the drug, which is ordinarily tolerated very well, but probably from the absorption of dead tissue products.

It should be emphasized that influence on growth, and not cure, is being discussed. In only a few instances did the tumor recede completely. Evidently, as indicated by histological study, most of the tumor cells were killed, but a few, especially around the large blood vessels, remained alive and grew again later. Microscopical sections showed profound and widespread changes in the tumors, with only occasional normal looking nests of cells. While histological changes in experimental tumors alone may not be very significant, it is felt that they have a decided significance in these experiments, not only because of the predictable and high frequency with which they occur massively in large tumors, but also because of their linkage with cessation of growth of the tumors.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

DEVICES FOR THE STUDY OF TWO PLANE SHIFTS IN THE CENTER OF GRAVITY OF A SWAYING BODY[1]

FIGS. 1 and 2 illustrate equipment assembled to record the magnitude and direction of the involuntary postural sway of man in the upright stance and to locate the center of weight with respect to the feet as a function of time. A base platform of channel iron rests on leveling screws. Upon it are mounted a platform scale, remodeled to record graphically transverse changes in load, and a second platform of channel iron resting, one side on knife-edges borne upon the scale, the other on frictionless ball-and-socket joint leveling screws. Upon the second platform is another scale modified to record antero-posterior changes in load. Finally, surmounting this is a third platform, which also rests upon knife-edges and leveling screws. Progressing from base to top, each platform may be independently made horizontal. The upper two are set at right angles to each other. They remain essentially level at all loads.

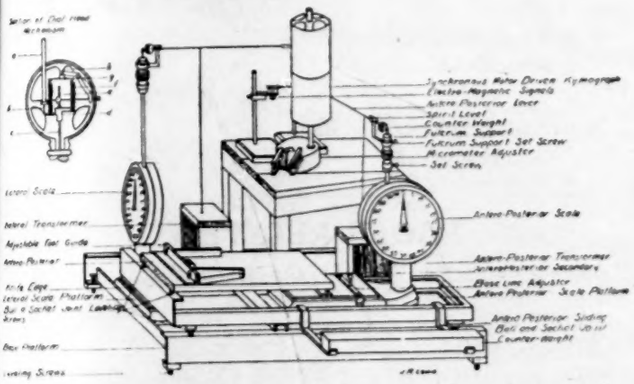

FIG. 1. Semi-perspective sketch of the equipment developed for the graphic registration of concurrent shifts of the center of gravity in the antero-posterior and transverse vertical orientation planes of a subject maintaining an upright stance. The key to the dial head symbols is as follows: a—vertical brass supporting tube; b—connecting rod joining the runner to the auxiliary lever system; c—steelyard connecting the long lever nose and the runner; d—runner; e—rack; f—mainspring; g—equalizer yoke; h—zero adjusting lever.

The inset of Fig. 1 shows a section of the dial head mechanism transformed to convert variations in main spring tension into vertical movements of a lever writing on the drum of a sub-synchronous motor operated kymograph driven at constant speed. Inserted in the dial head is a vertical brass tube sheltering a connecting rod brazed to the scale runner at its lower extremity and linked with a counterweighted auxiliary lever system at its projecting end. The fulcrum support for the auxiliary lever is provided with a wing-nut set-screw. It rests upon a main support supplied with a micrometer adjustment device bearing a knurled nut and a locking screw. By turning the knurled nut the fulcrum support is conveyed to such a position

[1] Supported in part by a grant from the Wisconsin Alumni Research Foundation.

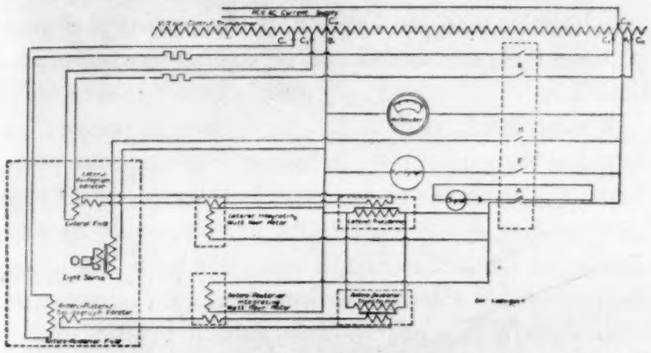

FIG. 2. Circuit diagram of the apparatus. The 110 volt AC supply leads into a partial underload tap changing auto-transformer. Lead C_a goes through a fuse to a semi-permanent connection. Lead C_b goes to a wiper arm on a terminal board, permitting this side of the power circuit to be connected to any of the low voltage taps at the right end of the windings in the diagram of connections. Bus bars B_1 and B_2 are also semi-permanently connected. They are in circuit with the voltmeter. By rotating the contact arm the voltage may be changed over a 9 volt range. Thus the bus bar voltage may be kept constant although the power supply voltage fluctuates. The left hand windings in the diagram are high voltage taps to which removable clip contacts C_1 and C_2 are connected. Contacts C_3 and C_4 are connected to the low voltage terminals. They pass through a double pole single throw switch K and from there connect to special resistors. Switch K energizes both the C_1C_3 and C_2C_4 circuits. It controls the power to the two fields of the compound watt oscillograph. Switch F controls the power to the synchronous motor driven kymograph. Switch H controls the power to the light source of the compound watt oscillograph. Switch A is a special two circuit switch. One circuit energizes the two slotted core transformers and the potential coil of two rotating standard watt hour meters. The second connection is a direct current circuit composed of a battery and an electromagnetic signal to indicate the beginning and ending of each observation. Thus the bus bars furnish power to several devices in parallel through switches F, A and H.

that the lever, guided by a permanently mounted spirit level, is brought easily to the horizontal. The whole system is then locked in position. Weight on the platform causes the nose of the long lever to be pulled down, depressing the runner, putting tension on the springs and proportionately rotating the lever. Knowing the knife-edge to joint distance, the weight of the subject, the scale indications and the tares, the location of the center of gravity may be calculated by equating moments. The oscillations in the center of gravity of a standing subject due to physiological sway may thus be graphically recorded and, by fixing the position of the feet with respect to the platform fulcra, may also be projected into a footprint of the base of support.

The secondary of a slotted core transformer excited from a constant potential source is suspended from each auxiliary scale lever. The voltage induced in each secondary is proportional to its distance in the slot and hence to the scale load. The secondaries are in series with the current coils of rotating standard watt hour meters. Since the potential coils are excited from the same source as the transformers, the watt

hour meters may be used to denote scale indications, or, if run for time T, to specify the average load. Thus may be calculated the location of the projected center of weight at any instant or its average position for time T.

A compound watt oscillograph was developed to expedite the location of successive instantaneous positions of the center of weight. It consists essentially of two slow speed watt units perpendicular to and facing each other. Each is composed of a laminated field made of transformer iron bent into a rectangle with an air gap on one side, and a shuttle wound vibrator. The vibrator and its field are so mounted on an aluminum base that their physical relations remain constant. The field coil consists of two spirals in parallel, excited from the auto-transformer that powers the slotted core transformers and the potential coils of the watt hour meters. Its voltage may be changed to allow for differences in the body weight of subjects. A shuttle is used to increase the inertia of the vibrating system, which thus indicates average, not instantaneous watts. It also increases the torque for the same current and provides a mirror base well out of line of the field, allowing good immersion in oil for damping. A beam of light falling on the mirror of watt unit No. 1 is reflected to the mirror of watt unit No. 2 and thence to a viewing screen or film. The current in the vibrator reacting against the flux due to the field sets up an instantaneous force which tends to rotate the vibrator from its no-current position. Since the field is constant, the vibrators occupy positions dependent upon distances of the secondaries in the slots, and hence, scale loads. Thus the projection of a light on a screen or film may be made to reproduce the oscillations of the center of gravity of a swaying subject. The unique feature of the oscillograph is its ability to compound two rectilinear motions, the resultant spot of light tracing concurrent shifts in the center of gravity occurring in the two cardinal vertical orientation planes.

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A METHOD FOR RAPIDLY EXCYSTING METACERCARIAE

STUDENTS of Trematodes commonly resort to the use of digestive enzymes to induce excystment of metacercariae. By this means the cyst wall may be broken down and the larva freed. This method, however, does not succeed at all times, nor in all forms; and usually requires the control of temperature within rather definite limits for several hours or longer. It is possible by a comparatively simple and rapid technique to dissect away the cyst wall and free undamaged metacercariae from cysts as small as those of Cryptocotyle (length *ca.* 0.35 mm, width *ca.* 0.26 mm).

The points of sewing needles (No. 9 or smaller), driven eye first into small, soft wooden handles, may be ground on a stone to flat cutting blades. At least two such needles are necessary. The cysts to be opened are placed with an appropriate fluid in a watch glass, and rolled onto the surface of a small piece of lens paper or cleansing tissue, either of which will serve as a convenient substratum to prevent rolling of the cyst. The cyst is held with one needle, while an opening in the wall is made with the other. The metacercaria immediately begins to emerge, and in so doing leaves a clear space in the cyst opposite the puncture. By pressing gently on this clear space, while the cyst is still anchored by the needle with which the opening was made, one may free the larva quickly and easily. The actual operation is carried out under an ordinary dissecting microscope and, with practice, should require little more than a minute.

Metacercariae so liberated may be mounted, covered and studied immediately.

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